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UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and
Information Administration
Washington, D.C. 20230

June 10, 2003

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

Re: Amendment of Part 76 of the Commission's Rules to Extend Interference Protection to the Manne and Aeronautical Distress and Safety Frequency 406.025 MHz, MB Docket No. 03-50

Dear Ms. Dortch:

Enclosed please find an original and four (4) copies of the late-filed Reply Comments of the National Telecommunications and Information Administration, U.S. Department of Commerce, in the above-referenced docket. A copy of the filing in a WordPerfect file is also provided on diskette.

Please direct any questions you may have regarding this letter to the undersigned. Thank you for your cooperation.

Respectfully submitted,

Kathy D. Smith

Kathy D. Smith
Chief Counsel

Enclosures

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JUN 10 2003

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Amendment of Part 76 of the Commission's Rules To Extend Interference Protection to the Marine and Aeronautical Distress and Safety Frequency 406.025 MHz	))))	MB Docket No. 03-50
	)	

REPLY COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

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Fredrick R. Wentland
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June 10, 2003

Table of Contents

EXECUTIVE SUMMARY

The National Telecommunications and Information Administration (NTIA) supports the Federal Communications Commission's (Commission) efforts to protect the international emergency distress frequency of 406.025 MHz. The protection of this emergency frequency is also supported by the Federal Aviation Administration, the United States Coast Guard, the Radio Technical Commission for Maritime Services (RTCM), and the National Oceanic and Atmospheric Administration (NOAA) Search and Rescue Satellite (SARSAT) Aided Tracking Program. The international Cosmicheskaya Systyema Poiska Avariynich Sudov - Search and Rescue Satellite (COSPAS-SARSAT) program announced its decision to terminate satellite processing of distress signals transmitted at 121.5 MHz and 243 MHz as of February 1, 2009. All emergency distress signals that are to be detected and relayed by satellite will then be transmitted in the 406 - 406.1 MHz band. As a result, protection of this frequency is critical to public safety around the world.

Therefore, NTIA supports extending interference protection to the emergency distress frequency of 406.025 MHz. Specifically, NTIA recommends that Section 76.616 be revised to extend interference protection to 100 kHz below 406.025 MHz and 100 kHz above 406.076 MHz. This revision to the Commission's proposed rules is consistent with recommendations made by RTCM and the SARSAT Aided Tracking Program Steering Group. The proposed extension of the frequency limits for interference protection to 405.925 - 406.176 MHz should not impact cable television service operations since the nearest video carriers are at 403.25 MHz and 409.25 MHz, and the nearest aural carrier is at 407.75 MHz.

NTIA believes that, for digital cable transmissions, the power level of the leakage signal can be measured using a root-mean-square detector instead of a peak detector. To adequately characterize the emissions in terms of interference impact to the COSPAS-SARSAT satellites, the measurement should be performed over a time interval of 2.5 milliseconds or less and in a measurement bandwidth of at least 30 kHz. For analog transmission systems, a peak detector, as proposed by the Commission, should be employed to measure the cable leakage signal.

NTIA supports the Commission's proposal to limit the power level of cable leakage signals to 10 microwatts. The transition to digital signals that employ modern equipment in conjunction with the monitoring requirements specified in the Commission's Rules will reduce potential interference from signal leakage. Given these factors, the power level proposed by the Commission should be adequate to protect the COSPAS-SARSAT receivers that are detecting signals from low-powered Emergency Position Indicating Radio Beacons and Emergency Locator Transmitters.

Before the
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Washington, DC 20554

In the Matter of	)	
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and Aeronautical Distress and safety Frequency	)	
406.025 MHz	)	
	)	

REPLY COMMENTS OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

The National Telecommunications and Information Administration (NTIA), an Executive Branch agency within the Department of Commerce, is the President's principal adviser on domestic and international telecommunications policy, including policies relating to the nation's economic and technological advancement in telecommunications. Accordingly, NTIA makes recommendations regarding telecommunications policies and presents Executive Branch views on telecommunications matters to the Congress, the Federal Communications Commission (Commission), and the public. NTIA, through the Office of Spectrum Management, is also responsible for managing the Federal Government's use of the radio frequency spectrum. NTIA respectfully submits the following reply comments in response to the Commission's Notice of Proposed Rulemaking and Order in the above-captioned proceeding.[1]

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[1] *In the Matter of Amendment of Part 76 of the Commission's Rules To Extend Interference Protection to the Marine and Aeronautical Distress and Safety Frequency 406.025 MHz*, MB Docket No. 03-50, Notice of Proposed Rulemaking and Order, FCC 03-37 (rel. March 5, 2003) ("NPRM").

I. BACKGROUND

The National Oceanic and Atmospheric Administration (NOAA) operates polar orbiting geostationary satellites that carry Search and Rescue Satellite (SARSAT) payloads providing distress alert and location information to appropriate public safety rescue authorities for maritime, aviation, and land users in distress. The Russian Federation operates very similar instruments known as Cosmicheskaya Systyema Poiska Avariynich Sudov (COSPAS) aboard satellites that are part of a navigation systems. Both are being used in an international cooperative search and rescue effort referred to as COSPAS-SARSAT.[2]

The system is made up of COSPAS-SARSAT satellites, terrestrial emergency transmitters, local ground stations, mission control centers (MCC) and rescue coordination centers (RCC). The COSPAS-SARSAT system is composed of three main subsystems, the distress beacon, the satellite repeater/processor, and the ground receiver processor. The distress signal is transmitted by a low-powered Emergency Locator Transmitter (ELT) or the maritime equivalent Emergency Position Indicating Radio Beacon (EPIRB) operating in the 406 - 406.1 MHz band. The EPIRB/ELT signal is detected by the receiver on the spacecraft and data is transmitted back to a Local User Terminal (LUT) on the ground, where the appropriate MCC and/or RCC is alerted.

NTIA supports the Commission's efforts to extend interference protection to include the SARSAT emergency distress frequency in the 406 - 406.1 MHz band. NTIA believes that this protection is warranted given the increasing use of 406.025 MHz EPIRBs and ELTs. NTIA

[2] The United States, Canada, France, and the Russian Federation are active participants in the development of the COSPAS-SARSAT system.

offers the following comments in response to specific issues raised in the NPRM.

II. THE FREQUENCY RANGE OF INTERFERENCE PROTECTION FOR THE 406.025 MHZ EMERGENCY DISTRESS SIGNAL SHOULD BE EXTENDED TO BE CONSISTENT WITH THE COSPAS-SARSAT 406 MHZ FREQUENCY MANAGEMENT PLAN.

In the NPRM, the Commission recognized that life saving efforts have been significantly aided by EPIRBs and ELTs operating on 406.025 MHz.[3] The Commission's Rules currently provide protection for the 121.5 MHz, 156.8 MHz, and 243 MHz frequencies, but do not include the 406.025 MHz emergency frequency.[4] Recognizing that the use of 406.025 MHz EPIRBs and ELTs has been increasing rapidly, the Commission in this NPRM proposed to amend Section 76.616 of its Rules to extend interference protection to the additional emergency distress frequency at 406.025 MHz.[5] The Commission's proposal would prohibit the transmission of carriers or other signal components within 100 kHz of 406.025 MHz.[6]

The 406.025 MHz emergency frequency has been designated internationally for distress use only. The international COSPAS-SARSAT Program announced that it will terminate satellite processing of distress signals from 121.5 MHz and 243 MHz EPIRBs and ELTs as of February 1, 2009.[7] The implication of this decision is that users of EPIRBs and ELTs that send distress alerts on 121.5 MHz and 243 MHz should begin using EPIRBs and ELTs operating on

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[3] NPRM at ¶5.

[4] 47 C.F.R. § 76.616.

[5] NPRM at ¶6.

[6] *Id.*

[7] Comments of the National Oceanic and Atmospheric Administration Search and Rescue Satellite Aided Tracking Program Steering Group, MB Docket No. 03-50 (April 30, 2003) at 2 ("NOAA SARSAT Steering Group Comments").

406.025 MHz if the alerts are to be detected and relayed via satellites. Mariners, aviators, and other persons will have to switch to EPIRBs and ELTs that operate on 406.025 MHz.

NTIA supports the Commission's action to provide interference protection to this important emergency frequency. However, NTIA believes that a revision to the Commission's proposed rule is necessary. The COSPAS-SARSAT 406 MHz frequency management plan now includes frequencies ranging from 406.025 MHz to 406.076 MHz. In addition to 406.025 MHz, 406.028 MHz is already in use, and 406.037 MHz will soon be available.[8] Therefore, in order to protect current and future 406 MHz EPIRB and ELT operations, NTIA recommends that Section 76.616 be revised to extend interference protection to 100 kHz below 406.025 MHz and 100 kHz above 406.076 MHz (the protected range would be 405.925 to 406.176 MHz).[9] This revision to the Commission's proposed rules is consistent with recommendations made by the Radio Technical Commission for Maritime Services (RTCM)[10] and NOAA's SARSAT Aided Tracking Program Steering Group.[11]

This proposed extension of the frequency limits for interference protection should not impact cable television service operations because the nearest video carriers are at 403.25 MHz

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[8] The COSPAS-SARSAT frequency management plan is available at: www.cospas-sarsat.org/download/T12-Nov0402withoutAnnexCandD.pdf; www.cospas-sarsat.org/download/T12-Nov0402AnnexC.pdf; www.cospas-sarsat.org/download/T12-Nov0402AnnexD.pdf.

[9] The COSPAS-SARSAT Search and Rescue Processor (SARP) subsystem has a receiver bandwidth of 24 kHz and the Search and Rescue Repeater (SARR) subsystem has a receiver bandwidth of 80 kHz.

[10] Comments of the Radio Technical Commission for Maritime Services (RTCM), MB Docket No. 03-50 (April 24, 2003) at 1.

[11] NOAA SARSAT Steering Group Comments at 1.

and 409.25 MHz, and the nearest aural carrier is at 407.75 MHz.[12] Thus, these cable signals are outside of the frequency range 405.925 to 406.176 MHz that is recommended by NTIA, RTCM, and the SARSAT Program Steering Group for interference protection of the 406.025 MHz emergency distress signal.

III. THE CABLE LEAKAGE SIGNAL LEVEL FOR DIGITAL TRANSMISSIONS CAN BE SPECIFIED IN TERMS OF AVERAGE POWER MEASURED USING A ROOT-MEAN-SQUARE DETECTOR.

The Commission proposed to limit the transmission of carriers or other signal components capable of delivering peak power levels equal to or greater than 10 microwatts at any point in the cable television system.[13] The specification of the limit in terms of peak power is based on analog cable transmissions. However as pointed out in the comments submitted by RCN Telecom Services, Inc. (RCN)[14] and the National Cable & Telecommunications Association (NCTA),[15] cable operators are in the process of transitioning a substantial portion of their system's operation to digital transmissions. Both RCN and NCTA believe that the Commission's proposal to restrict signal leakage levels based on peak power is not necessary to protect the reception of EPIRB and ELT emergency distress signals.[16]

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[12] NPRM at ¶6, n. 14.

[13] *Id.* at ¶6.

[14] Comments of the RCN Telecom Services, Inc., MB Docket No. 03-50 (April 30, 2003) at 4 ("RCN Comments").

[15] Comments of the National Cable & Telecommunications Association, MB Docket No. 03-50 (April 30, 2003) at 3 ("NCTA Comments").

[16] RCN Comments at 4; and NCTA Comments at 4.

RCN raises a valid point regarding the difference between analog and digital transmissions. Analog signals over cable can reach their highest power level at a particular frequency within an authorized band and it is valid to express the power limits in terms of peak power. Therefore, the peak detector measurement as proposed by the Commission is still applicable for analog transmission systems. On the other hand, digital transmissions produce signals that have equal power levels across all frequencies (at all times) in an authorized band. Thus, for digital signals, measuring the power in terms of average power is reasonable.

More specifically, NTIA believes that, for digital cable transmissions, instead of measuring the power level of the cable leakage signal using a peak detector, a root-mean-square (RMS) detector can be employed. The RMS detector measures the average power based on RMS voltage levels. NTIA recommends that in order to properly assess the potential for interference to a COSPAS-SARSAT satellite receiver, the power levels should be measured over a time interval that is related to the bit durations of the EPIRB and ELT distress signals. The EPIRB and ELT distress signals employ digital phase shift keying modulation with a data rate of 400 bits per second.[17] The duration of a data bit is the inverse of the data rate or 2.5 milliseconds (1/400). Performing the RMS measurement over a time interval of 2.5 milliseconds or less should provide a reasonable estimation of the average power level. The COSPAS-SARSAT Search and Rescue Processor subsystem has a receiver bandwidth of 24 kHz and the Search and Rescue Repeater subsystem has a receiver bandwidth of 80 kHz. Therefore, NTIA recommends that the measurements be performed using a resolution bandwidth of at least 30 kHz, which will

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[17] *Description of the Payloads Used in the COSPAS-SARSAT LEOSAR System*, C/S T.003, Issue 3 - Revision 1 (Oct. 2001) at 2-2.

adequately characterize the emissions in terms of the interference impact to a COSPAS-SARSAT satellite receiver.

IV. THE POWER LEVELS PROPOSED BY THE COMMISSION FOR CABLE LEAKAGE SIGNALS ARE ADEQUATE TO PROTECT LOW-POWERED EMERGENCY DISTRESS SIGNALS TRANSMITTED AT 406.025 MHZ.

The Commission proposed to adopt a power level for cable signal leakage of 10 microwatts (-50 dBW) to protect the 406.025 MHz emergency distress signal.[18] This proposal is consistent with the power level required to protect the emergency communications frequencies at 121.5 MHz, 156.8 MHz, and 243 MHz. As concluded by the Commission in a previous rulemaking, these frequencies carry emergency communications that may originate from unusual locations and from very low-powered portable units, thus it is appropriate to forbid transmission of carrier and other signal components at these frequencies.[19] Because the same constraints will apply to the EPIRBs and ELTs that transmit distress signals at 406.025 MHz, the Commission appropriately proposed to adopt the same power limits for cable leakage.

RCN believes that its system and those of other cable operators generally are not susceptible to signal leakage sufficient to cause interference to aeronautical frequencies, and therefore, should not be required to adopt measures to protect new additional frequencies such as 406.025 MHz.[20] NTCA believes that, given the existing signal leakage performance criteria, it is unnecessary to impose additional constraints on cable operators to protect 406.025 MHz

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[18] NPRM at ¶6.

[19] *Amendment of Part 76 of the Commission's Rules to Add Frequency Requirements and Restrictions and to Require Monitoring for Signal Leakage from Cable Television Systems*, Docket No. 21006, Report and Order, 65 F.C.C.2d 813, 827-28 (1977).

[20] RCN Comments at 3.

emergency distress signals.[21] NTIA notes that neither RCN or NCTA provided a technical rationale to support these arguments.

NTIA believes that the power limits for cable leakage as specified in Section 76.616 of the Commission's Rules have proven to be adequate to protect the reception of emergency distress signals at 121.5 MHz, 156.8, and 243 MHz. Therefore, it is reasonable to believe that adopting the same power limit to protect the 406.025 MHz emergency distress signal as proposed by the Commission is appropriate. An assessment of the potential interference to SARSAT satellite receivers based on the cable signal power level proposed by the Commission is provided in Annex A. The assessment shows that for the cable leakage signal level of 10 microwatts, as proposed by the Commission, even a small number of cable leakages in view of the SARSAT satellite can result in an aggregate power density that exceeds the interference threshold of the receivers detecting the low-powered emergency distress signals.

The transition to digital signals that employ modern equipment in conjunction with the monitoring requirements specified in the Commission's Rules will reduce potential interference from signal leakage. Given these factors, the power level proposed by the Commission should be adequate to protect the COSPAS-SARSAT receivers that are detecting signals from low-powered EPIRBs and ELTs. This limit should be achievable, since as RCN points out, most cable operators will transmit digital signals over a closed system of fiber-optic and coaxial cable and generally do not use over the air transmissions.[22] Therefore, NTIA supports the Commission's proposal to limit cable leakage signals to a power level of 10 microwatts.

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[21] NCTA Comments at 5.

[22] RCN Comments at 3.

V. CONCLUSION

For the foregoing reasons, NTIA urges the Commission to extend interference protection to include the 405.925 to 406.176 MHz frequency range to protect current and future emergency distress signals; to specify the cable leakage signal level in terms of RMS average power for digital signals; and to adopt the power level of 10 microwatts as measured in a bandwidth of 30 kHz for cable leakage signals. These recommendations would greatly facilitate the protection of the emergency distress signal in the 406 - 406.1 MHz band that will eventually be used by all marine, aviation and land users.

Respectfully submitted,

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ANNEX A

ASSESSMENT OF THE POTENTIAL INTERFERENCE FROM CABLE LEAKAGE SIGNALS TO SARSAT SATELLITE RECEIVERS

1. BACKGROUND

The United States, Canada, France, and the Russian Federation are active participants in the development of the international Search and Rescue Satellite (COSPAS-SARSAT) system. The system is made up of SARSAT and COSPAS satellites, terrestrial emergency transmitters, local ground stations, mission control centers (MCC) and rescue coordination centers (RCC). The SARSAT system concept is that of low-altitude polar orbiting satellites using Doppler techniques to determine the position of a distressed aircraft, ship, or other vehicle from the low-powered emission of an automatic distress beacon.

The SARSAT system is composed of three main subsystems, the distress beacon, the satellite repeater/processor, and the ground receiver processor. The distress signal is transmitted by the Emergency Locator Transmitter (ELT) or the maritime equivalent Emergency Position Indicating Radio Beacon (EPIRB). The signal is detected by the receiver on the spacecraft and data is transmitted back to a Local User Terminal (LUT) on the ground, where the appropriate MCC and/or RCC is alerted.

The processed data system is available only for the 406.025 MHz ELT/EPIRB signals. These signals contain data as to the type of platform, country of origin, identification of ship or aircraft, and type of emergency. The information is in the form of phase shift keying (PSK) modulation. The signals are recovered, detected and identified by processing on the spacecraft.

The SARSAT system contains two coverage modes: regional mode and a global coverage mode. The regional coverage mode provides coverage to those areas where the satellite is mutually visible to both the ELT/EPIRB and the LUT. The global coverage mode provides full earth coverage by storing data in the spacecraft until it can be transmitted to the next available LUT. This allows coverage of large maritime areas that otherwise would be out of range of any individual LUTs.

The SARSAT 406-406.1 MHz Search and Rescue Processor (SARP) and Search and Rescue Repeater (SARR) subsystems of the SARSAT will be considered in this analysis. The development of the interference criteria will be based on the performance requirements specified in an approved International Telecommunication Union-Radiocommunications Sector (ITU-R) recommendation.[23] This recommendation contains the protection criteria for the COSPAS-SARSAT SARP and SARR in the band 406-406.1 MHz to be used as a basis for analysis of potential interference from cable leakage signals.

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[23] International Telecommunication Union-Radiocommunications Sector, Recommendation ITU-R M.1478, *Protection Criteria for COSPAS-SARSAT Search and Rescue Processors (SARP) in the Band 406-406.1 MHz*, (June 2000).

2. INTERFERENCE MECHANISM

The potential interference into a SARSAT satellite receiver will be investigated based on aggregate interference from a number of leakage sources that are in the field of view of the satellite, because a single leakage source will not impact the receiver. The average power from multiple sources add linearly in a conventional narrowband receiver.[24] This is well supported by theoretical considerations. For example, communications theory texts clearly show that for stationary, stochastic processes, average power from multiple independent sources add linearly.[25]

Ignoring the effects of atmospheric refraction, the total area of the Earth visible from a satellite is given by:

$$A = 2\pi(r_e)^2(\beta-1)/\beta \qquad \text{and} \qquad \beta = 1 + h/r_e \qquad \text{(A-1)}$$

where

r_e is the radius of the Earth (6378 km);
h is the altitude of the satellite (km).

Using Equation A-1, the area visible from a COSPAS-SARSAT satellite at an altitude of 850 km is approximately 30×10^6 km^2.[26]

3. SARSAT INTERFERENCE PROTECTION CRITERIA

For this analysis, it is assumed that the individual digital cable leakage signals will appear noise-like. Based on the central limit theorem, if there were a large number of cable leakage signals, a SARSAT SARP or SARR receiver would actually see an aggregate signal that would produce a noise-like interference effect.

The addition of broadband noise to the SARP or SARR receiver will have the effect of increasing the system bit error rate (BER), and therefore adversely affecting its performance. The maximum acceptable uplink BER for the SARP or SARR cannot exceed 5×10^{-5}. Based upon this requirement, the following paragraphs will identify the maximum allowable interference to noise ratio associated with broadband noise in the SARP or SARR uplink channel.

The SARP or SARR typical receiver characteristics are noise figure of 2.5 dB, nominal background noise temperature of 1000 K, and attenuation between the antenna and the SARP or

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[24] The average power is based on root-mean-square (RMS) voltage.

[25] Athanasios Papoulis, *Probability, Random Variables and Stochastic Processes*, at Chapter 10 (McGraw-Hill 1965).

[26] SARSAT altitudes range from 833 to 870 km.

SARR receiver is 1.6 dB. Thus, the system noise temperature at the input of the SARP or SARR receiver equals 1010 K, and therefore, the noise spectral density is computed using Equation A-2.[27]

$$N_0 = 10 \text{ Log } (k\ T_{sys}) \tag{A-2}$$

where:

k is Boltzmann's constant 1.38×10^{-23} (W/K/Hz);
T_{sys} is the system noise temperature (K).

Using the system noise temperature of 1010 K, the noise density is found to be:

$$N_0 = 10 \text{ Log } [(1.38 \times 10^{-23})\ (1010)] = -198.6 \text{ dBW/Hz}$$

The worst-case specification states that the SARP is designed to operate correctly when the received carrier signal has a power (C) of -161 dBW (minimum level of the received signal) at the input of the receiver, which provides an effective E_b/N_0 of 9.1 dB in the bit detector of the SARP or SARR if beacon waveform and the various losses are taken into account. In this case, the corresponding BER equals 2.6×10^{-5}.

Therefore, in order to achieve a BER 5×10^{-5} (which is an approximate doubling of the BER) the maximum acceptable degradation is 0.3 dB. At $E_b/N_0 = 8.8$ dB, the BER equals 4.8×10^{-5}.

The additive noise corresponding to the 0.3 dB degradation of the carrier-to-noise density (C/N_0) is calculated next. Let I_0 represent the additive noise power density coming from the unwanted interferers. The initial N_0 noise becomes $N_0 + I_0$. The C/N_0 becomes $C/(N_0+I_0)$. The interference margin (MI) is computed using Equation A-3.

$$MI = C/N_0 - C/(N_0 + I_0) \tag{A-3}$$

The interference power density to noise power density ratio (I_0/N_0) is computed using Equation A-4.

$$I_0/N_0 = 10 \text{ Log } (10^{MI/10} - 1) \tag{A-4}$$

For an interference margin of 0.3 dB the I_0/N_0 is given by:

$$I_0/N_0 = 10 \text{ Log } (10^{0.3/10} - 1) = -11.4 \text{ dB}$$

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[27] In a separate calculation a system noise temperature of 1006 K was calculated instead of the 1010 K specified in ITU-R M.1478.

The interference power density protection threshold is then computed from:

$$I_T = N_0 + I_0/N_0 = -198.6 + -11.4 = -210 \text{ dBW/Hz}$$

This interference power density threshold corresponds to a interference temperature of 73 K, and therefore an approximate increase of approximately 7% of the system noise temperature at the input of the SARP or SARR receiver.

4. ANALYSIS OVERVIEW

In this analysis, the interference power density is computed using the cable signal leakage power level proposed by the Commission and SARP and SARR receivers and antenna gain characteristics. The computed interference power density is then compared to the noise-like interference power density protection threshold for the SARP and SARR receivers to determine the amount of available margin. Based on the available margin, the number of cable leakage signals that can occur before the interference power density threshold is exceeded is determined.

The interference power density is computed using Equation A-5.

$$I_0 = EIRP + G_r - L_p - L_s \qquad \text{(A-5)}$$

where:

I_0 is the calculated interference power density (dBW/Hz);
EIRP is the equivalent isotropic radiated power density of the cable leakage signal (dBW/Hz);
G_r is the SARP and SARR Receive Antenna Gain (dBi);
L_p is the radiowave propagation loss between the SARSAT satellite and the cable leakage sources (dB);
L_s is the system/insertion losses (dB).

The difference between the interference power density threshold computed in Section 2 and the interference power density computed using Equation A-5 represents the available margin (M_{avail}). Assuming the emissions of the individual cable leakages appear noise-like and add linearly, the number of cable leakage sources (N_{Leak}) that would have to be in view of the SARSAT receivers before the interference power density threshold is exceeded is determined by:

$$N_{Leak} = 10^{Mavail/10}$$

5. PARAMETERS USED IN ANALYSIS

The following paragraphs will discuss each of the parameters used in the analysis.

5.1 Equivalent Isotropic Radiated Power (EIRP). The power level of the leakage signal proposed by the Commission is 10 microwatts which is equal to -50 dBW. If it assumed that the power level is measured in 30 kHz resolution bandwidth the power density is:

$$-50 \text{ dBW} + 10 \text{ Log } (1/30000) = -95 \text{ dBW/Hz}$$

In this analysis the signal leakage is assumed to be radiated omni-directionally with an associated antenna gain of 0 dBi. The equivalent isotropic radiated power used in this analysis is -95 dBW/Hz.

5.2 Receive Antenna Gain (Gr). The SARP receive antenna gain used in the analysis is determined from Figure A-1.[28] The antenna gain of -6.7 dBi used in the analysis corresponds to an angle off-nadir of 0 degrees. The antenna pattern for the SARP receiver is shaped to approximately compensate for range variation. Therefore, cable leakage signals within the satellite field of view will be received at approximately the same level for all elevation angles to the satellite.

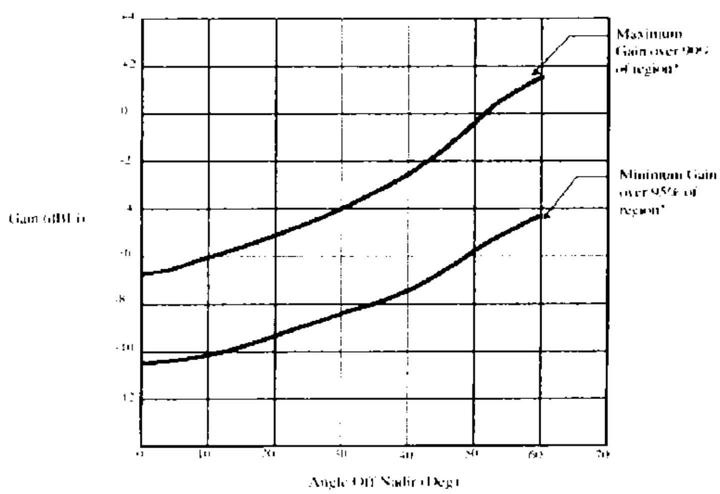

Figure A-1. SARP Receive Antenna Pattern

The antenna gain for the SARR used in this analysis is -2.2 dBi.[29]

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[28] *Description of the Payloads Used in the COSPAS-SARSAT LEOSAR System*, C/S T.003, Issue 3 - Revision 1 (Oct. 2001) at 5-11.

[29] This value of antenna gain was provided by the SARSAT Program Office.

5.3 Radiowave Propagation Loss (Lp). The free-space propagation model is used to compute the radiowave propagation loss between the SARSAT satellite and the cable leakage sources. The radiowave propagation model described by the free-space loss equation is shown in Equation A-6.

$$L_p = 20 \text{ Log } F + 20 \text{ Log } D + 32.45 \tag{A-6}$$

where:

F is the frequency for the SARP/SARR (MHz);
D is the distance separation between the SARSAT satellite and the cable leakage sources (km).

For a frequency of 406.025 MHz and a satellite altitude of 850 km, the free-space propagation loss computed using Equation A-6 is approximately 143 dB. This propagation loss ignores any effects resulting from building or terrain blockage.

5.4 System/Insertion Losses (Ls). A system/insertion loss of 2 dB is used in the analysis to account for any losses between the receive antenna and the receiver input.

An overview of the parameters used in the analysis for the SARP are presented in Table A-1.

Table A-1. SARP Parameters Used in Analysis

Parameter	Value
EIRP	-95 dBW/Hz
G_r	-6.7 dBi
L_p	143 dB
L_s	2 dB

An overview of the parameters used in the analysis for the SARR are presented in Table A-2.

Table A-2. SARR Parameters Used in Analysis

Parameter	Value
EIRP	-95 dBW/Hz
G_r	-2.2 dBi
L_p	143 dB
L_s	2 dB

6. ANALYSIS RESULTS

The results of the analysis for the SARP are presented in Table A-3.

Table A-3. SARP Analysis Results

Parameter	Value
EIRP	-95 dBW/Hz
G_r	-6.7 dBi
L_p	143 dB
L_s	2 dB
I_0	-247.9 dBW/Hz
I_T	-210 dBW/Hz
M_{avail}	37.4 dB
N_{Leak}	5,495

The results in Table A-3 show that at the power level proposed by the Commission, if there are 5,495 cable leakage sources in the field of view of the COSPAS-SARSAT satellite the SARP receiver interference density threshold is exceeded. For a satellite at an altitude of 850 km the visible area is approximately 30×10^6 km^2. Assuming that half of the area visible to the satellite is over populated land, the number of cable leakage sources per square kilometer is:

$$(5495/15 \times 10^6) = 0.0004 \text{ leakages/km}^2.$$

The results of the analysis for the SARR are presented in Table A-4.

Table A-4. SARR Analysis Results

Parameter	Value
EIRP	-95 dBW/Hz
G_r	-2.2 dBi
L_p	143 dB
L_s	2 dB
I_0	-242.2 dBW/Hz
I_T	-210 dBW/Hz
M_{avail}	32.2 dB
N_{Leak}	1,660

The results in Table A-4 show that at the power level proposed by the Commission, if there are 1,660 cable leakage sources in the field of view of the SARSAT satellite the SARR receiver interference density threshold is exceeded. For a satellite at an altitude of 850 km the visible area is approximately 30 x 10^6 km^2. Assuming that half of the area visible to the satellite is over populated land, the number of cable leakage sources per square kilometer is:

$$(1660/15 \times 10^6) = 0.0001 \text{ leakages/km}^2.$$

7. CONCLUSION

The analysis shows that for the cable leakage signal level of 10 microwatts, as proposed by the Commission, even a small number of cable leakages in view of the SARSAT satellite can result in an aggregate power density that exceeds the interference threshold of the SARP and SARR receivers. This aggregate interference level can potentially cause interference that can disrupt the reception of the low-powered emergency distress signals at 406.025 MHz. Therefore, increasing the allowable leakage signal power level or eliminating the limit on the power level of the leakage signal is not acceptable.

The cable operators indicate that they will be primarily deploying digital signals near 406.025 MHz. Using modern and advanced equipment will reduce the potential interference from signal leakage. The cable systems are also carefully monitored for signal leakages in accordance with the Commission's Rules. Given this transition to digital signals and the monitoring efforts by cable operators, the power levels for cable leakage proposed by the Commission are adequate to protect reception of the emergency distress signal at 406.025 MHz.